WATER MANAGEMENT IN ALBERTA

CHALLENGES FOR THE FUTURE

BACKGROUND PAPER

VOLUME 8

WATER MANAGEMENT PROJECTS

Alberta
ENVIRONMENT

ISBN: 0-7732-0645-0
August 12, 1991

Printed on Recycled Paper

91-06968/

SUMMARY

VOLUME 8: WATER MANAGEMENT PROJECTS

Volume eight provides an overview of water management projects as well as information about their operation and maintenance. Irrigation and hydroelectric development are two specific areas of water management that are explained.

CHAPTER 1: WATER MANAGEMENT PROJECTS

For many years the Alberta government has developed and managed a wide variety of water management projects. The purpose of these projects is to manage Alberta's water resources in support of the overall economic, social and environmental objectives of the province. Projects in southern Alberta usually supply water for the diversified multipurpose needs of a semi-arid but fertile region. They also meet Alberta's inter-provincial apportionment requirements. Projects in central and northern Alberta mitigate damages such as flooding and erosion caused by surface water and enhance conditions for multipurpose use of available water resources.

Currently, Alberta Environment is responsible for four programs that provide funding for water management projects:

1) Surface Water Development and Control Program,

2) Alberta Water Management and Erosion Control Program,

3) Farm Surface Water Management Program, and

4) Irrigation Headworks and Main Irrigation Systems Improvement Program.

There are water related programs in Alberta that complement the role of the water management programs. Various departments manage and administer these projects. The environmental and socio-economic impact that these programs may have on the province's overall water management strategy needs to be considered.

The background paper describes water management programs run by Alberta Environment and programs run by other departments more fully.

CHAPTER 2: OPERATION AND MAINTENANCE OF WATER MANAGEMENT PROJECTS

Alberta Environment is responsible for monitoring, operating, inspecting, and maintaining many water management projects throughout the province. There are two main types of projects:

1) Provincial projects which address various water management problems across the province, are developed by the Surface Water Development and Control Program and the Water Management and Erosion Control Program; and,

2) Headworks systems are the major water supply projects which divert water from southern Alberta rivers for water supply throughout the area for use by towns, villages, recreation, wildlife, and industry as well as irrigation. Control of these diversions also assists Alberta in meeting its interprovincial commitments on water.

These projects fulfill specific water management objectives such as water supply, flood control, water storage, erosion control, lake stabilization and flow augmentation. Operations are carried out according to pre-determined plans that often include public input.

The current inventory of provincial projects and headworks systems should be operated and maintained to such a standard that they all continue to function effectively. Alberta Environment continues to implement additional flood and erosion control projects, stabilize declining lake levels, enhance wetlands habitat, and provide more irrigation water supplies. The background paper raises further issues that will affect the operations and maintenance of these water management projects in the future.

CHAPTER 3: WATER FOR IRRIGATION

The major consumer of water in Alberta is irrigation. Alberta Environment has ownership responsibilities most of for the major structures, canals, and storage reservoirs used to divert water from rivers and streams. Most of this water is provided to Irrigation Districts who distribute the water to users.

Nearly 100 years ago, railway companies started construction of large scale irrigation projects in Alberta, in the hope that they would attract settlers and thus increase railroad revenues. Several farmer owned irrigation districts were built in the 1920's and 1930's. Then in response to the drought of the 1930's, the federal government reconstructed and enlarged the St. Mary Irrigation project to provide water to 500,000 acres of irrigated land.

Although irrigation expanded rapidly in the 1970's, the expansion slowed in the 1980's as many of southern Alberta's rivers and streams approached full allocation. Recently, Alberta Environment announced expansion limits for irrigation in the South Saskatchewan Basin.

The supply of water for irrigation has had a significant impact on the landscape and economy of southern Alberta. The available water is limited, yet irrigation produces more than 20% of the province's net cash crop receipts. Municipalities, recreation sites, wildlife and waterfowl are other beneficiaries of irrigation.

The background paper discusses issues that affect the future decisions regarding irrigation. They include:

- salinization
- efficiencies of water conveyance and application systems
- the value of water
- irrigation need vs. instream flow needs
- water quality of return flows
- quality of water supply for irrigation

CHAPTER 4: HYDROELECTRIC DEVELOPMENT

Alberta produced the first hydroelectric energy on the Bow River in Calgary near the turn of the century. The Bow River system still has the largest number of hydro projects in the province. Since the rapid growth period of the '70s, there has been no new hydroelectric capacity put in service in the province. However, some small projects are under construction in southern Alberta that make use of existing water conveyance systems.

Hydro electric projects, while producing environmentally clean energy, do have associated environmental concerns. These include the following:

- significant changes in the distribution of river flows over a year
- short-term flow fluctuations associated with power production for peaks in power demand
- flooding associated with reservoirs
- fluctuations in reservoir levels that detract or limit other uses of the reservoir
- reservoir shoreline stability
- the quality of water within the reservoir

Hydro projects also can produce positive benefits such as increasing downstream flows during otherwise low-flow conditions, downstream flood protection, reservoir fisheries, water-based recreation as well as reliable water supplies from the reservoir.

Many of the impacts associated with hydroelectric developments can be mitigated to varying degrees at the project planning and design stage, and later by the operating methods.

Various factors will influence the future of hydroelectric energy development. Two significant ones will be environmental considerations and the unit cost of energy produced compared to alternate sources of electric energy.

TABLE OF CONTENTS

VOLUME 8: WATER MANAGEMENT PROJECTS

Summary

Chapter 1: Water Management Projects 1

Chapter 2: Operation and Maintenance of Water Management Projects 9

Chapter 3: Water for Irrigation 12

Chapter 4: Hydroelectric Development 18

WATER MANAGEMENT PROJECTS

INTRODUCTION

Water is one of Alberta's most important natural assets. It is a primary, vital natural resource and an important catalyst for balanced economic development. Alberta has a major responsibility to manage its water resources because of the province's geographic position as custodian of the headwaters of some of the country's important watersheds. Water management decisions made in Alberta have far reaching implications for present and future generations in this province and in many parts of Canada.

Alberta has a geographic imbalance between the area of greatest water supply and the area of greatest water demand. The southern half of the province has approximately 15 percent of the total water supply, but 80 percent of the total water demand. Water management problems in southern Alberta are generally related to shortage of supply, while flooding and erosion are major concerns in northern Alberta.

Seasonal variations in flows also present water management problems. The river discharges vary from early summer peaks to very low winter flows. The high flows occur for a relatively short time but move enormous volumes of water. Without some form of flow regulation, these large volumes of water pass through Alberta unused, and in some cases, cause flood and erosion damage.

The Prairie Provinces Master Agreement on apportionment reached between Canada, Alberta, Saskatchewan and Manitoba on October 30, 1969, requires Alberta to pass downstream into Saskatchewan 50 percent of the natural flow of the South Saskatchewan River Basin at the Alberta-Saskatchewan Boundary. This requirement has an impact on the planning and development of water management projects in southern Alberta.

For many years the Alberta government has been involved in the development and management of a wide variety of water management projects. The basic purpose of these projects is to manage Alberta's water resources in support of the overall economic and social objectives of the province. The water management projects in southern Alberta are generally intended to supply water for the diversified multipurpose needs of a semi-arid but fertile region of the province, and to enable Alberta to meet the inter-provincial apportionment requirements. Projects in the central and northern parts of the province are necessary to mitigate damages such as flooding and erosion caused by surface water, and to enhance conditions for multipurpose use of the available water resources.

Currently, Alberta Environment is responsible for four programs which provide funding for water management projects: 1) Surface Water Development and Control Program; 2) Alberta Water Management and Erosion Control Program; 3) Farm Surface Water Management Program; and 4) Irrigation Headworks and Main Irrigation Systems Improvement Program. The major Reservoir Development Program, which is managed and administered by Alberta Public Works, Supply and Services, is directly related to the water management requirements of Alberta Environment. There are a number of complementary programs related to water resources management funded by the provincial government and managed and administered by Alberta Agriculture and Alberta Transportation.

Since 1975, the province has spent about $1 billion on water management projects through program, administered by Alberta Environment and Alberta Public Works, Supply and Services. Programs involving irrigation

infrastructure rehabilitation and improvement and water supply by Alberta Agriculture have accounted for expenditures amounting to about $400 million. Further, approximately $700 million has been expended on water supply programs administered by Alberta Transportation and Utilities.

SURFACE WATER DEVELOPMENT AND CONTROL PROGRAM

Seasonal variations of flows in streams present many water management problems and challenges to Albertans. In the central and northern parts of the province, spring runoff and occasional summer storms can cause flood damage to crops and property resulting in economic hardships to Albertans and damage to the environment. Although water is in abundance in northern Alberta, obtaining good quality water for domestic consumption often is a problem. In semi-arid southern Alberta, low precipitation during the winter and summer months, compounded by the lack of soil moisture and the effect of searing winds, contributes to drought conditions in the region. These droughts can impose hardships to the region's water supply systems, and adversely affect fish and wildlife habitat. Water quality of the rivers can also pose problems due to extremes in the natural flows. The Alberta Government's Surface Water Development and Control Program is intended to alleviate some of these disparities and damage caused by natural variance in surface water flows.

The purpose of this program is to develop an adequate and controlled supply of water and to remove or mitigate the adverse effects imposed by water (or the lack of water) in its natural state. The government of Alberta provides assistance in the form of engineering and funding to develop projects to mitigate damages and to enhance conditions to allow for the multipurpose use of the province's water resources.

The program was initiated in the mid-1950s, and since then hundreds of projects have been implemented throughout the province. The various types of projects include flow regulation dams and reservoirs, lake stabilization structures, flood control and drainage channelization works, water supply pipelines, erosion control structures, water conservation, fishways and enhancement of wildlife habitat (see Figure 1 in Volume 8, Chapter 2: "Operation and Mainenance of Water Management).

The total capital cost to date of projects implemented under the program since 1977 is approximately $80 million. The average annual expenditures have been in the order of $5 million. The projects varied in size from multi-million dollars to under $10,000. Some of the larger projects built under the program include McLennan-Girouxville Water Supply Canal, the Namepi-Kennedy Flood Control Project, the Pine Creek Flood Control Project, the St. Paul-Lac St. Cyr Waterline, the Tyrrell-Rush Wildlife Habitat Enhancement Project, the Hutch Lake Recreation Dam and Reservoir Project, and the Podruzney Drainage Project. A further $210 million was spent implementing the Dickson Dam and Paddle River Dam projects.

In order for a project to be funded under this program, it must meet the following basic criteria: a) create substantial benefits to a relatively large area of the province; b) have widespread demonstrated need; c) be technically, environmentally and economically feasible; and d) should promote sound water management.

Projects under this program are generally initiated through requests for assistance to resolve water-related problems by urban or rural municipalities. These requests are made through the regional offices of the Water Resources Administration Division of Alberta Environment, located in Peace River, Edmonton, Red Deer, Calgary and Lethbridge. The regional staff inspect and investigate the problems, and then advise on their eligibility for funding under "Provincial Water Management Projects". Alberta Environment conducts preliminary engineering studies to determine the technical, economical and environmental feasibility of projects. Larger water development projects go through conceptual and feasibility studies, rigorous cost-benefit analysis, public hearings

and detailed environmental impact assessments before approval for implementation is granted by the government. Once they have been approved for implementation, Alberta Environment is responsible for the engineering design, and manages the construction of the projects. Alberta Environment is also responsible for operation and maintenance of these projects after completion of construction.

ALBERTA WATER MANAGEMENT AND EROSION CONTROL PROGRAM

In 1972, the government of Alberta recognized the need for an equitable, practical and easily applied policy on financial assistance for cost-sharing of water resource projects. This resulted in the introduction of policy on cost-sharing for water management projects entitled Position Paper #5 under the ***Water Resources Act***.

Under this program, the province of Alberta agreed to cost-share with local authorities on all water management projects which have direct public benefit. Local authority means a city, town, village, municipal district, or the Minister of Municipal Affairs in the case of an Improvement District or Special Areas. The Board of Directors of an Irrigation District or the Board of Trustees of a Drainage District are also considered to be local authorities. Water management projects were initially cost-shared with the local governments on a 50-50 percent basis.

In 1980, Position Paper #5 was revised to increase the portion of the provincial grant from 50 to 75 percent and to provide more decision-making authority to local governments by allowing them to hire their own engineering consultants to design and implement the projects.

In 1985 the Alberta government decided to increase the assistance available for agricultural flood and erosion control projects. This changed the formula to 86-14 percent provincial-local government basis. The name of the program was changed to the Alberta Water Management and Erosion Control Program. This program also recognized northern Alberta as an area that differs from the rest of Alberta in characteristics and conditions related to higher erosion susceptibility. In recognition of the special needs of the area, the province provides 100 percent of the engineering costs, 75 to 86 percent of the construction costs and 75 percent of the maintenance costs of all projects under the program. Over the past nine years the province has spent approximately $87 million under this program with annual grants ranging from $3.2 million to $6.3 million.

The various types of projects include the following: flood control and drainage channelization works; erosion control and bank stabilization projects; flow regulation and lake stabilization structures; water-based recreation reservoirs; fish, waterfowl and wildlife enhancement projects; water supply projects; water conservation projects; urban storm water projects; and existing sewage (storm and sanitary) outlets.

Projects under this program are initiated through requests by local authorities to Alberta Environment. Once a request is received, the proposed project is assessed as to its eligibility for assistance under the grant program. The local authority conducts a preliminary engineering study and prepares a report. This report addresses the technical, economical and environmental aspects of the project and provides an estimated cost for the works envisaged with recommendations for implementation. Alberta Environment reviews this report and grants approval to proceed with the project. An agreement is then signed between the Minister of the Environment and the local authority, after which the project is implemented in accordance with the agreement. The local authority is responsible for detailed engineering and construction.

FARM SURFACE WATER MANAGEMENT PROGRAM

The province also provides technical assistance to landowners under a program called the Farm Surface Water Management Program. The purpose of this program is to provide technical services only to individual landowners and small groups of farmers to resolve minor flood control, drainage, erosion and other water-related problems. The technical services provided include engineering, surveys and designs, cost estimating, construction supervision and licencing assistance. Landowners are responsible for construction and related costs. The projects are co-ordinated through local authorities and Agricultural Service Boards.

IRRIGATION HEADWORKS AND MAIN IRRIGATION SYSTEMS IMPROVEMENT PROGRAM

There are approximately 1.2 million acres under irrigation in 13 irrigation districts in southern Alberta. The headworks systems that supply water to these districts have been in operation for almost 60 years. Improving, modernizing and upgrading these systems along with the construction of additional storage was deemed necessary in order to meet not only existing demand, but also the expanding level of multipurpose use.

The water management headworks' main canals are the life lines of southern Alberta's economy and infrastructure. In addition to irrigation, these systems supply water to 48 communities and 14 industrial users. There are 50 developed recreational facilities on the storage reservoirs which provide for boating, swimming, water skiing and fishing plus a wide range of shoreline activities. Water from these systems provides for the development of more attractive, liveable farmsteads with shelterbelts, lawns and gardens. It also provides greater flexibility in cropping alternatives in response to market demands, as well as increased employment stability at the rural and small community level.

In 1974, the Alberta government made a policy decision to assume responsibility for the operation and maintenance of the major water management headworks systems. A program to rehabilitate the headworks systems was initiated in 1975 and significantly expanded in scope following the Cabinet decision in 1980 to proceed with an integrated water resources management plan for southern Alberta. This decision was based on recommendations of the Oldman River Management Committee, the Caucus Committee on Water Resources and the Environment Council of Alberta.

The responsibility for administering and managing the Irrigation Headworks and Main Irrigation Systems Improvement Program, which is a major component of the integrated water management plan, was entrusted to Alberta Environment. The purpose of this program is to ensure that adequately sized, efficient, reliable water supply delivery systems are available to all 13 irrigation districts and to the Berry Creek region in Special Areas.

The following projects were undertaken under this Program:

- Lethbridge Northern Headworks Rehabilitation and Expansion including Keho Lake Reservoir Enlargement (30,000 acre feet)

- Waterton/St. Mary Headworks System Upgrading
- Carseland/Bow Headworks System Upgrading
- Western Headworks System Rehabilitation
- United Irrigation District Headworks System Rehabilitation
- Mountain View/Aetna/Leavitt Headworks System Upgrading
- Cavan Lake Headworks System Upgrading
- St. Mary River Irrigation District Main Canal Rehabilitation
- Eastern Irrigation District Main Canals Rehabilitation
- Forty Mile Coulee Reservoir Development in the St. Mary River Irrigation District (70,000 acre feet)
- Badger Lake Reservoir Development in the Bow River Irrigation District (42,000 acre feet)
- Crawling Valley Reservoir Development in the Eastern Irrigation District (90,000 acre feet)
- Deadfish Diversion Project in Special Areas
- Sheerness Water Supply Project in Special Areas

This is a 15-year improvement program funded under the Alberta Heritage Savings Trust Fund and scheduled for completion by 1995 at a total estimated cost of $584.2 million. Work has been initiated on all of the components and by March 31, 1991, approximately 80 percent of the program was complete. The total expenditures to date amount to approximately $473.0 million. During the past three years the annual expenditures have been in the $35-40.0 million range. Completed projects include all the offstream storage reservoirs, Lethbridge Northern Headworks System rehabilitation and upgrading, St. Mary River Irrigation District main canal rehabilitation and the Sheerness and Deadfish projects in Special Areas (see map).

Major emphasis under the program has been placed on modernizing the existing water conveyance systems to improve their operational capability and delivery efficiency, and on controlling seepage from the canals with a view to minimizing damage to adjacent farmland and conserving water.

Prior to irrigation development in southern Alberta, there were only a few lakes that would support fish or waterfowl. This type of habitat was generally restricted to river valleys or mountain areas. Over the years, much wildlife habitat became established in the areas served by the headworks systems. The improvement program places a major emphasis on the preservation and enhancement of fish and wildlife habitat within project areas. Examples of such enhancement facilities may be seen at the storage reservoirs and some canals. A walleye rearing pond to improve fish stocks at Forty Mile Coulee Reservoir and a trout pond at a rehabilitated section of the Lethbridge Northern Irrigation District main canal have been developed. A new fish ladder was incorporated at the Lethbridge Northern Irrigation District diversion headworks. Waterfowl enhancement areas have been developed at Keho Lake and Badger Lake Reservoirs by Ducks Unlimited. In the Eastern Irrigation District canal rehabilitation project, every effort is being made to maintain the existing wetland areas along the canal.

The program has brought direct benefits to the agricultural industry and substantial spin-off benefits to the socio-economic and the environmental well-being of the region. At the inception of this program, priority was placed on the rehabilitation and improvement to those headworks and districts' main canal systems which were in poor condition and required immediate attention. Recent evaluation of delivery canals of other districts and headworks systems suggest that there is an urgent need to rehabilitate and upgrade these systems as well.

MAJOR RESERVOIR DEVELOPMENT PROGRAM

Under this program the Alberta government provides capital funding for the implementation of large scale reservoir development projects in major river basins in the province. Initiated in 1988, the funds for implementation of projects are provided from the Capital Fund. The program is managed and administered by Alberta Public Works, Supply and Services Department.

The Oldman River Dam, presently being constructed near Pincher Creek in southern Alberta at an estimated cost of about $353 million, is a major component under this program. These two projects are planned for implementation under the program:

- Little Bow Basin Development Project;
- Willow Creek Basin Development Project.

COMPLEMENTARY PROGRAMS

INTRODUCTION

There are a number of water-related programs in the province of Alberta managed and administered by various departments that complement the role of the province's water management projects. The environmental and socio-economic impacts, tangible and intangible, that these programs may have on the province's overall water management strategy need to be considered in the process of planning and implementation of our Water Management Projects. A brief description of these complementary programs is given below.

Irrigation Rehabilitation And Expansion Program (ICW 86/14)

Since 1976, the Alberta Heritage Savings Trust Fund has provided funding to the 13 irrigation districts to rehabilitate and enlarge their water distribution infrastructure. Funds are cost-shared on an 86 percent provincial 14 percent irrigation district basis. This program is managed and administered by Alberta Agriculture. As of March 31, 1991, the province has invested $312 million in this program. Funding levels are currently at the $25 million per year level.

Alberta Private Irrigation Development Assistance Program (APIDA)

The APIDA Program was developed to provide financial assistance to agricultural producers developing private irrigation schemes from sources outside the organized irrigation districts. The program assists in drought-proofing, intensifying and diversifying their operations with high quality long-lasting efficient irrigation systems. The program was initiated in 1989, and is managed and administered by Alberta Agriculture.

The program has been structured to provide up to $10 million in capital grants to eligible applicants over a five-year period from April 1989 to March 1994. Funding is provided by the Alberta Heritage Savings Trust Fund.

Farmland Development And Reclamation Program (FDRP)

The FDRP, managed and administered by Alberta Agriculture, is designed for rural municipalities to encourage improved on-farm water management. This is accomplished by cost-sharing demonstration projects that illustrate how to increase the productivity of farmland by enhancing soil moisture levels and providing water on farms for domestic, livestock and other purposes. Technical assistance is provided for projects including slough consolidation to improve field operations or provide domestic/livestock water supply and controlled drainage to improve soil moisture through greater infiltration.

Approximately two-thirds of the province's rural municipalities are participating in the program. The program is cost-shared with municipalities on a 60 percent provincial 40 percent municipal basis. Annual provincial expenditures are at the $200,000 per year level.

Provincial Dugout Pumping Program 1990

The dugout pumping program is a drought assistance program managed and administered by Alberta Agriculture. An important aspect of the program is that the equipment is made available at the same cost to all the farmers in the province, regardless of their location.

Alberta Municipal Water Supply And Sewage Treatment Grant Program

This grant program, managed and administered by Alberta Transportation and Utilities, assists Alberta municipalities with the construction of water supply and sewage treatment facilities. Annual expenditures have varied from $23 million in 1989 to $100 million in 1982.

Alberta Regional Utilities Grant Program

This program, managed and administered by Alberta Transportation and Utilities, is very much similar to the program referred to above, except that it provides funding for water supply projects involving two or more municipalities. Since its initiation in 1979, the province has expended approximately $65.0 million under this program.

Alberta Farm Water Supply Grant Program

Initiated in 1985, this program provides funding assistance for installation of water supply systems to water co-ops. The eligibility for funding is decided on the premise that the water co-ops are made up of a number of farms.

Approved projects under this program are on a 75 percent government/ 25 percent Co-op basis and up to a maximum of $15,000 grant per farm or $25,000 total project costs. The total expenditures to date on this program is about $33 million. Annual expenditures have been in the order of $4-6 million. The program is managed and administered by Alberta Transportation and Utilities.

Northern Supplementary Fund Assistance Program

The purpose of this program is to provide funding to municipalities within the jurisdiction of the Northern Alberta Development Council for initiating or improving water and sewage facilities where, even with local revenues and other sources of income, the costs of projects are far in excess of the provincial norm. Preference is given to communities with a demonstrated health problem, low tax base, and insufficient sources of other funds so as to render the project financially feasible.

This program, administered by Alberta Transportation and Utilities, will expire in March 1992.

OPERATION AND MAINTENANCE OF WATER MANAGEMENT PROJECTS

INTRODUCTION

Alberta Environment is responsible for monitoring, operating, inspecting and maintaining a large number of water management projects throughout the province. There are two general categories of projects:

- Provincial Projects - those which have been developed by way of the Surface Water Development and Control Program and the Water Management and Erosion Control Program described in the "Government Funding of Water Management Projects" background paper;
- Headworks Systems - the major water supply projects, transferred to Alberta from the federal government in 1974, which divert water from a number of southern Alberta rivers for water supply throughout the area including towns, villages, recreation, wildlife and industries as well as irrigation. The historical development of headworks projects is described in more detail in the "Water For Irrigation" chapter.

PROVINCIAL PROJECTS

There are a total of 244 provincial projects, located throughout Alberta as shown on Figure 1. These include: 40 dams and reservoirs operated to regulate flows, and control flooding and erosion; 21 weir and lake level regulation projects; three water supply pump stations; and 180 flood and erosion control projects representing almost 1000 kilometres (600 miles) of channelization. The current replacement value of the provincial projects is estimated at $1.0 billion. The annual operation and maintenance expenditures for these projects is approximately $3.5 million, which represents .35 percent of the total replacement costs.

HEADWORKS SYSTEMS

Alberta Environment is currently responsible for operation and maintenance of eight headworks systems, located as shown on Figures 1 and on Map 1 in Chapter 3. The headworks infrastructure includes six diversion weirs, 10 dams and storage reservoirs, and a large number of drop structures, turnouts, flumes, syphons and bridges in 300 kilometers (190 miles) of large conveyance canals.

A major portion of southern Alberta is dependent on the water provided through the headworks systems. Approximately 1.4 million acres are irrigated with water supplied to 13 Irrigation Districts and to private irrigators adjacent to the headworks. Forty-eight towns and villages, 50 developed recreational facilities, 14 industrial users and a commercial fishery benefit from the operation of these projects. Waterfowl and wildlife habitat has been created adjacent to the conveyance channels and around the reservoirs.

The total replacement value of the headworks is estimated at $2.0 billion. The annual operation and maintenance expenditure for these systems is approximately $3.4 million, which is about .17 percent of the replacement cost of the infrastructure.

OPERATION

All provincial projects and headworks systems have been developed to fulfill specific water management objectives such as water supply, flood control, water storage, erosion control, lake stabilization and flow augmentation. Most projects have several purposes and objectives in response to various needs. Those that have operational requirements, such as dams and pump stations, are managed in order that these objectives and needs are met, and the resulting benefits are realized. These benefits are derived from the many ways in which water is used, including municipal and domestic purposes, recreational uses, irrigation and industrial purposes, and fish and wildlife habitat. Operations are carried out in accordance with pre-determined plans which, for major multipurpose projects, have been developed with public input. The provincial projects and headworks systems in the South Saskatchewan River basin are operated to best meet the needs in the basin and to meet Alberta's interprovincial apportionment agreement to allow 50 percent of the flow to pass into Saskatchewan. Effective operations are the key to conserving the water resource today so that future generations can also benefit from its many uses.

All major dams are required to formulate an Emergency Preparedness Plan (E.P.P.) depending on the potential hazard to the general public. The E.P.P. outlines the measures that project operators will take in event of an unusual flood occurrence at the dam and includes a list of individuals and agencies (such as the R.C.M.P., Town Managers) who must be contacted if communities downstream of the dam will be affected.

MAINTENANCE

All provincial and headworks projects require maintenance to ensure that they continue to perform their water management function, whether it be a small ditch to control flooding, or a large dam which supplies water for thousands of irrigated acres. Flood control and drainage channels are continually subjected to erosion, siltation, weed and tree growth, and when their capacities are exceeded by high runoff events, channel crossings and grade control structures can be damaged or washed out. Concrete and metal components of dams, weirs and other structures deteriorate over time in the harsh Alberta climate with its freeze/thaw cycles. Control gates on dams and diversion structures have electrical and mechanical systems that need constant attention. Pump stations and pipelines have unique maintenance requirements related to river intakes, pump stages, wet wells, control valves, sensors and large electrical motors. Timely maintenance is essential to protect Alberta's water management infrastructure, valued at nearly $3 billion, and to minimize the possibility of property damages and loss of life, and economic benefits due to structural failure.

Alberta is the only province which has enacted specific dam safety legislation. This legislation applies to all dams over 7.6 meters (25 feet) high and as such includes many of the projects under Alberta Environment's responsibility. The Smaller dams under 12 meters (40 feet) high require a formal inspection every 5 to 10 years; larger dams require annual inspections. Owners must collect data on instrumentation where applicable, and perform routine inspections and maintenance checks in order to submit the necessary Dam Safety Reports. The

WATER RESOURCES MANAGEMENT PROJECTS

NORTHERN ALBERTA

O/Δ PROVINCIAL PROJECTS - 157

CENTRAL ALBERTA

O/Δ PROVINCIAL PROJECTS - 62

SOUTHERN ALBERTA

□ HEADWORKS SYSTEMS - 8

O/Δ PROVINCIAL PROJECTS - 25

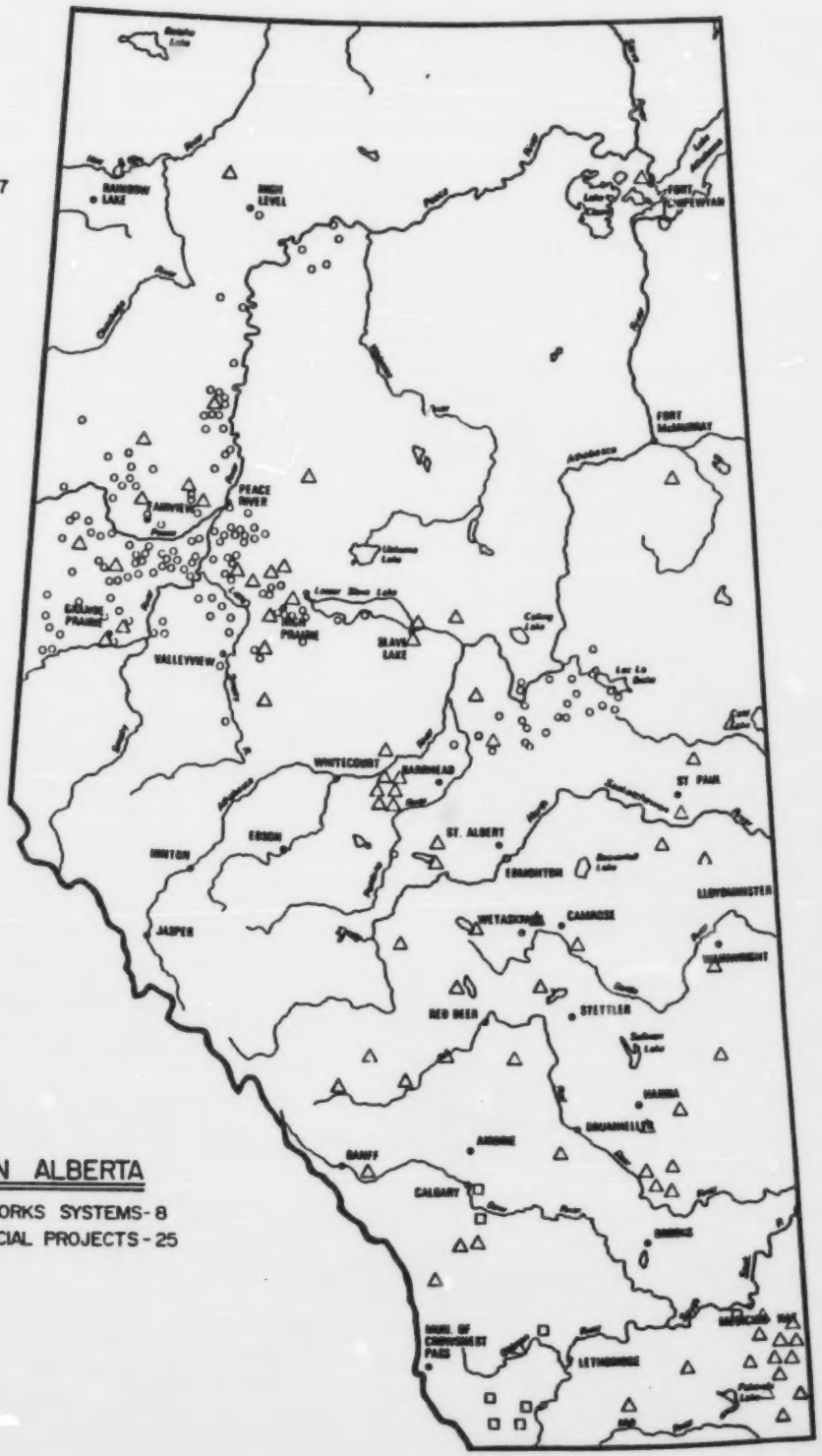


FIG. 1

safety of dams and indeed all projects and systems is necessary for the protection of the general public, both public and private property, and to provide the benefits that flow from the management of water.

Experience in other jurisdictions (Bureau of Reclamation in the U.S.A.) indicates that the annual cost of operating and maintaining water management structures is in the order of one to five percent of their replacement value, depending on the nature of the project. Current operation and maintenance budgets for Alberta Environment's provincial projects and headworks systems are about .35 percent and .17 percent respectively of their replacement value. It would appear from this comparison that there is a serious gap in provincial maintenance funding. As a result, some projects may deteriorate to such an extent that expensive rehabilitation may be required.

The dams, reservoirs, flood control channels, water supply systems, diversion weirs, lake stabilization works and all the related projects which make up Alberta Environment's water management infrastructure serve a variety of needs and provide a diversity of benefits to Albertans, and to Alberta's wildlife waterfowl and fishery resources.

All provincial projects and headworks systems should be operated and maintained to such a standard that they all continue to function effectively. There is a continuing demand to implement additional flood and erosion control projects, stabilize declining lake levels, enhance wetlands habitat, and provide more irrigation water supplies. It is expected that dozens of new projects will be constructed in the next few years. The implications on the province's operation and maintenance resources are significant. An adequate level of maintenance is required so that projects and systems continue to function safely and properly, and continue to provide the benefits originally intended and currently expected.

QUESTIONS FOR DISCUSSION

- Should Alberta own and operate water management projects? If not who should?
- Should beneficiaries of water management projects, such as local authorities or individuals, contribute to their operation and maintenance?
- What sort of cost sharing arrangement between the government and water users would be appropriate, or should users or beneficiaries pay all the direct costs of operating and maintaining those projects from which they receive the benefits?

WATER FOR IRRIGATION

INTRODUCTION

The major consumer of water in Alberta is irrigation. Currently over 1,400,000 acres of land are being irrigated in southern Alberta, about 4% of the Province's cultivated land base.

Alberta Environment is a key player in the supply of water for irrigation since it owns the Headworks System including the structures, canals, and storage reservoirs used to divert water from rivers and streams. The majority of this water is provided to Irrigation Districts, who in turn distribute the water to users within their boundaries through a complex system of canals and offstream storage reservoirs (see drawing 'Irrigated Acreages and Main Supply Systems'). Alberta Environment also has the legislative authority to allocate water for irrigation under the ***Alberta Water Resources Act.***

As a result of a recent review of water availability in the South Saskatchewan River basin, Alberta Environment announced that irrigation acreage could be increased, but would be limited to 1.7 million acres in total.

HISTORY

Major irrigation development in Alberta was started by railway companies which were given ownership of large tracts of land by the Canadian government. The railway companies used irrigation as a means of encouraging people to settle these lands with the hope that the settlers would generate revenues for the railroad.

The first significant irrigation water supply system, the St. Mary Irrigation Project, was initiated in the late 1890s by Elliot T. Galt (son of Alexander T. Galt, one of the fathers of Confederation) and Charles A. Magrath (first mayor of Lethbridge), both representing the Alberta Railway and Coal Company. They entered into a joint venture with the Mormon Church to divert water from the St. Mary River for irrigation of land in the Magrath, Raymond and Lethbridge areas. Water was first turned into this system in 1900. By 1919, 65,000 acres of land were being irrigated.

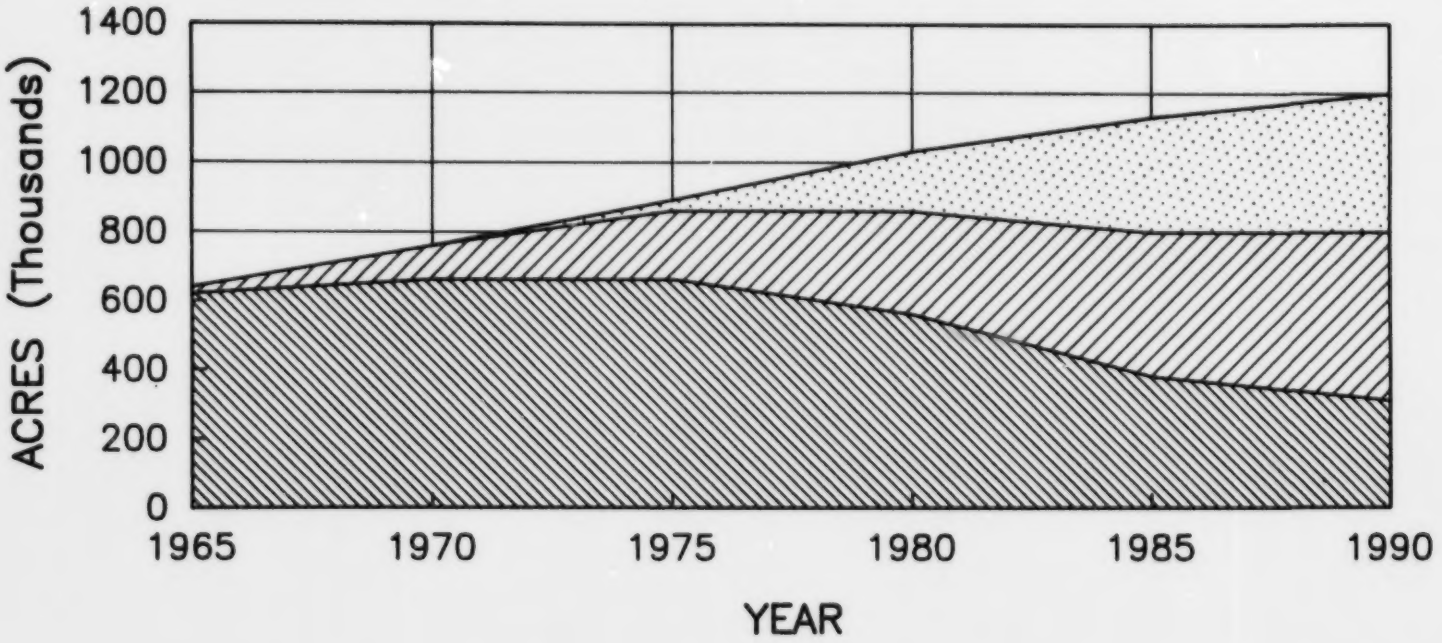
In the early 1900s, the Canadian Pacific Railway started construction on two projects to divert water from the Bow River onto large tracts of land north of the river between Calgary and Medicine Hat. These systems formed the basis of the Western Irrigation District near Calgary and the Eastern Irrigation District near Brooks.

In 1909, an English firm called the Southern Alberta Land Company started construction of another system to divert water from the Bow River to irrigate lands in the Vauxhall area south of the Bow River. This system now forms part of the Bow River Irrigation District.

The ***Irrigation Districts Act*** was passed in 1915, allowing farmers to establish their own administrative and operational organizations. Several more Irrigation Districts were formed in the 1920s and 1930s.

IRRIGATION METHOD

ALBERTA IRRIGATION DISTRICTS



The Government of Canada organized the Prairie Farm Rehabilitation Administration (PFRA) in 1935, to provide financial assistance for water development projects on the prairies in response to widespread drought. A major project constructed jointly by the Governments of Alberta and Canada was the headworks system consisting of dams on the Waterton River and the St. Mary River, the Belly River diversion, several large off-stream reservoirs and hundreds of kilometres of canals. This system allowed water to be diverted from the Waterton, St. Mary and Belly rivers to supply water to the St. Mary Irrigation Project. The improved water supply system would allow the project to expand its irrigated acreage to 500,000 acres from the Rocky Mountain foothills to Medicine Hat. In 1968, the project's distribution systems were turned over to the farmers. The headworks system remained with PFRA until 1973, when it was transferred to Alberta Environment.

The Province of Alberta is committed to multipurpose use of water throughout Alberta and to the interprovincial agreement on apportionment of water, which requires Alberta to pass 50 percent of the natural flow of eastward flowing rivers on to Saskatchewan. In order to ensure that it is able to meet these commitments, the province made the decision in 1974 to take control of all major diversions of water from Alberta's largest rivers and streams. These headworks systems controlled by Canada had already been turned over to the Province in 1973. Since 1974, most of the headworks systems operated by the Irrigation Districts have also been turned over to the Province of Alberta.

IRRIGATION WATER TODAY

Expansion of irrigated acreage was rapid in the late 1970s (see graph) as irrigators changed over from the original surface gravity method of irrigation to the less labour intensive sprinkler method. This also permitted lands situated above canals and rivers to be irrigated. The rate of expansion slowed in the 1980s as water in many of southern Alberta's rives and streams became fully allocated. Today, Alberta has over 1.4 million acres of irrigated land (see Map 1). Approximately 1.2 million acres are contained within the 13 irrigation districts which distribute water to their irrigators. The districts, owned and operated by their water users, are quasi-municipal bodies operating under the legislative authority of the ***Alberta Irrigation Act*** . The districts manage their own affairs through an elected Board of Directors which oversees operations and levies,and collects water rates among other powers and duties.

Outside the boundaries of the irrigation districts, another 230,000 acres, referred to as private irrigation, are irrigated by individual farmers. Each private irrigator has a distinct license issued in accordance with the Alberta ***Water Resources Act***.

LIMIT TO WATER SUPPLY FOR IRRIGATION

Alberta Environment recently announced expansion limits for irrigation int he South Saskatchewan basin (see table 1). The guidelines limit the expansion to a total of 1.7 million acres, an increase of 334,000 acres from the 1988 level. Continuing work on instream flow needs will assist in refining the guidelines for limiting irrigation expansion. These guidelines will be reviewed in the year 2000.

Table 1
WATER MANAGEMENT IN THE SOUTH SASKATCHEWAN RIVER BASIN
IRRIGATION EXPANSION GUIDELINES
(in thousands of acres)

	1988 Acres.	Proposed Expansion Limits	Proposed Total Limits
Red Deer Basin	40	57	97
Bow Basin	576	99	675
Oldman Basin	708	176	884
Sub-basin	51	2	53
Total SSRB	1,375	334	1,709

The water that is available in southern Alberta is limited. The South Saskatchewan and the Milk River basins account for less than 15 percent of Alberta's river water. It is estimated that irrigation at its full development level could consume 75 percent of Alberta's share of the water in the South Saskatchewan River basin in an average year. In a dry year, this percentage would be closer to 90 percent of Alberta's portion of the total flow. Table 2 shows recent irrigation district utilization of the natural flow from that portion of the South Saskatchewan river upstream of Medicine Hat (ie. Bow and Oldman rivers). In those years where over 50 percent of the flow was diverted, the remainder of Alberta's commitment to Saskatchewan under the Apportionment Agreement would have come from Red Deer river flows.

OTHER FACTS ABOUT WATER SUPPLY FOR IRRIGATION

The supply of water for irrigation has had a significant impact on the landscape and economy of southern Alberta. Irrigation produced over 20 percent of the province's net cash crop receipts in the late 1980s, yet irrigated land occupies only 4 percent of the cultivated land base. Figures based on 1980-85 data[1] show that, on average, irrigated crops produce a net income of $150/acre as opposed to $20/acre for dryland crops in the Lethbridge area. This extra income allows irrigated lands to support a much greater population base than does dry land.

Water supply for irrigation has benefitted more than just agriculture. Forty-eight municipalities rely on water supplied either directly or within the irrigation districts by the provincially owned headworks systems. Over 3,000 individuals use these water delivery networks for stock and domestic water supply.

1 Oldman River Dam, Economic Analysis, Marv Anderson & Associates Ltd., January, 1986

Alberta
ENVIRONMENT

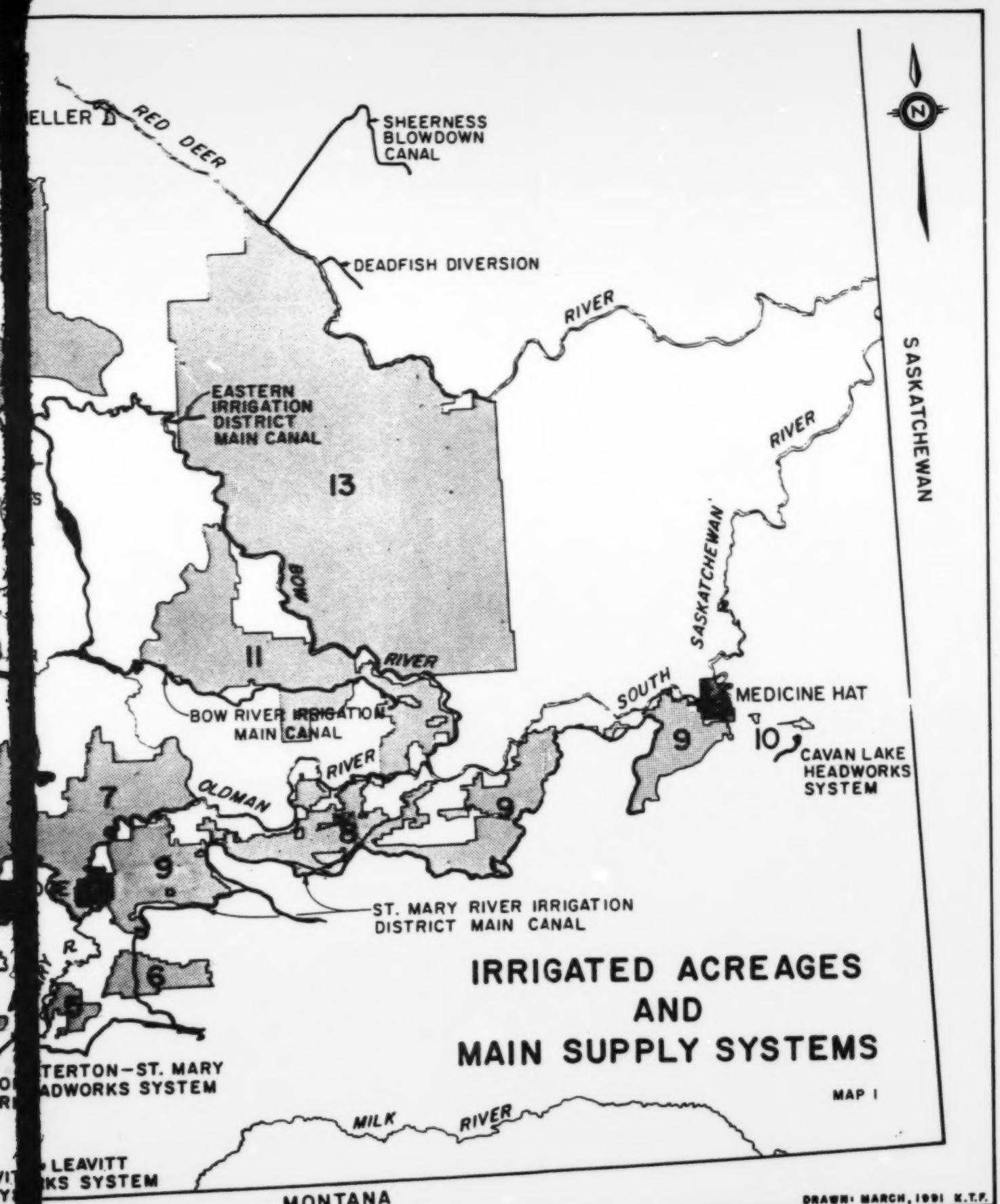
PRIVATE IRRIGATION: IRRIGATION ACREAGES – 1988

OLDMAN RIVER BASIN	68 000 Ac.
BOW RIVER BASIN	45 000 Ac.
RED DEER RIVER BASIN	40 000 Ac.
SO. SASK. RIVER SUBBASIN	50 000 Ac.
MILK RIVER BASIN	21 000 Ac.

IRRIGATION DISTRICTS: IRRIGATION ACREAGES – 1988

1. MOUNTAIN VIEW IRR. DIST.	4 000 Ac.
2. LEAVITT IRR. DIST.	5 000 Ac.
3. AETNA IRR. DIST.	3 000 Ac.
4. UNITED IRR. DIST.	34 000 Ac.
5. MAGRATH IRR. DIST.	15 000 Ac.
6. RAYMOND IRR. DIST.	44 000 Ac.
7. LETHBRIDGE NORTH IRR. DIST.	22 000 Ac.
8. TABER IRR. DIST.	74 000 Ac.
9. ST. MARY RIVER IRR. DIST.	339 000 Ac.
10. ROSS CREEK IRR. DIST.	1 000 Ac.
11. BOW RIVER IRR. DIST.	192 000 Ac.
12. WESTERN IRR. DIST.	86 000 Ac.
13. EASTERN IRR. DIST.	253 000 Ac.

SOURCE OF BASE MAP:
ALBERTA AGRICULTURE
IRRIGATION DISTRICTS, MARCH, 1983


ELLER D
RED DEER
SHEERNESS
BLOWDOWN
CANAL
DEADFISH DIVERSION
RIVER
SASKATCHEWAN
EASTERN
IRRIGATION
DISTRICT
MAIN CANAL
13
RIVER
SASKATCHEWAN
BOW
11
RIVER
SOUTH
MEDICINE HAT
BOW RIVER IRRIGATION
MAIN CANAL
9
10
CAVAN LAKE
HEADWORKS
SYSTEM
RIVER
7
OLDMAN
9
8
9
ST. MARY RIVER IRRIGATION
DISTRICT MAIN CANAL
R.
6
5
TERTON–ST. MARY
ADWORKS SYSTEM
IRRIGATED ACREAGES
AND
MAIN SUPPLY SYSTEMS
MAP 1
MILK
RIVER
LEAVITT
KS SYSTEM
MONTANA
DRAWN: MARCH, 1991 K.T.F.

These are 50 developed recreation sites, including six provincial parks, adjacent to canals and reservoirs. The major reservoirs have a significant commercial fishery which in 1989 produced well over 100,000 kilograms of fish. Wildlife and waterfowl are major beneficiaries of the habitat provided by the reservoirs and wetlands as part of the water storage and delivery systems. In five of the largest Irrigation Districts,170,000 acres of habitat are available on 1200 water bodies.

ISSUES AND QUESTIONS FOR DISCUSSION

The issues facing irrigators and all water managers today are increasingly complex. Society's views are changing; the economies of water are changing; the demand for water in southern Alberta is increasing from a wide variety of users. The water supply is now a limiting factor to irrigation expansion. The ability to recognize and work with people and ideas from a variety of disciplines will be a great challenge. Following are some of the main issues, with respect to water for irrigation:

Salinization

Salts in the soil can be brought to the surface by water travelling through the soil and then evaporating, leaving the land barren. Salinization problems associated with irrigated lands are decreasing as the canal systems are rehabilitated and seepage is brought under control, and as on-farm management of irrigation water is improved.

- Can salinization be reduced further and at what cost?

Efficiencies of Water Application and Conveyance Systems

Often the water conveyance systems and irrigators are criticized for "wasting" water. Efficiency is defined as the amount of water utilized by the irrigated crop as a percentage of the water diverted from the source.

- Can Irrigation efficiencies be improved on a cost effective-basis?

Over the last 10-15 years, irrigation districts and irrigators, in co-operation with the province of Alberta, have been carrying out a program of rehabilitation and modernization of the distribution systems. These are some of the methods being used to improve efficiencies:

- using pipelines instead of canals,
- installing small balancing reservoirs to minimize operational spills,
- improving communication systems among water users, operating personal and district managers,
- using modern mechanical, electrical and/or computer control systems at key locations,
- lining canals with waterproof membranes such as plastic and concrete,
- re-using spill and drainage water,
- relocating and straightening canals, and

- changing over from gravity to sprinkler irrigation.

Value of Water

With water in such great demand in southern Alberta, many argue that it can no longer be treated as a free good. Irrigators recognize their costs in withdrawing water. Pumping cost can vary form $10.00 to $60.00/acre/year for the operation and maintenance of pumping units. As well, irrigators within an irrigation district pay an average of $10/acre/year toward the district's upkeep and operations.

- Should charges for irrigation water use be instituted?

Irrigation Needs vs. Instream Flow Needs

Experience has shown that irrigators generally tend to under-irrigate their crops by an average of 20 percent due to high energy costs and a lack of time for irrigation. Irrigators are moving toward meeting the optimum water application rate, which will put a greater stress on the water supply and, consequently, on maintaining desired instream flows in our rivers.

- During periods of severe drought, how should water shortages be handled?
- Should this matter be addressed in legislation?
- Can irrigators withstand a certain amount of water shortages and to what extent?

(See background paper on "Water Quality/Quality Interrelationship" for further discussion.)

Water Quality of Return Flows

To date, the water quality of return flows from irrigated areas in Alberta has generally been acceptable.

- Should minimum standards be set for these return flows?
- Should irrigation districts be required to monitor the water quality of their return flows?

Quality of the Water Supply for Irrigation

The quality of the water supplied to all water users, including irrigators, must be acceptable. Water is not only applied to crops, but is a major source of water for human and livestock consumption. One water quality concern facing irrigation districts withdrawing water from the Bow River is that high nutrient levels in the water are promoting heavy weed growth in their canals, resulting in a decreased canal capacity.

- Can water quality improvements be made to the Bow River to reduce the weed problems experienced by the three irrigation districts which supply water to over 500,000 acres of irrigated land?

Irrigation Expansion Guidelines

Guidelines for the expansion of irrigation acreage have been established by Alberta Environment because demand for irrigation water exceeds the available supply.

- The guidelines are subject to review in the year 2000. How should this review be accomplished?

Transferability of Water Rights

The ***Water Resources Act*** does not permit the transfer/sale of irrigation water rights.

- Should the transfer/sale of an irrigation water right, or a portion thereof, be permitted?
- If so, should such transfers be regulated?
- Could the use of the transferred water right be changed (e.g., from an irrigation use to a municipal use).

TABLE 2

Comparison of the Natural Flow of the South Saskatchewan River at Medicine Hat to Irrigation Districts Diversions (for April through October)

	1982	1983	1984	1985	1986	1987	1988	1989	Average 1982-89
*South Saskatchewan River at Medicine Hat (acre. feet x 1,000)	4,103	3,542	3,158	5,618	4,910	3,733	3,050	4,378	4,061
Total Irrigation District Diversions in South Saskatchewan River Basin (acre. feet x 1,000)	1,413	1,923	2,159	2,040	1,913	1,883	2,364	1,874	1,946
Irrigation Districts' Diversions as % of South Saskatchewan River (Medicine Hat)	34.4	54.3	68.4	36.3	39.0	50.0	77.5	42.8	47.9

*Flows are total South Saskatchewan River Basin Flow minus fluws from the Red Deer River at Drumheller.

All flow totals are for the months of April to October, inclusive, since irrigation districts do not operate during winter.

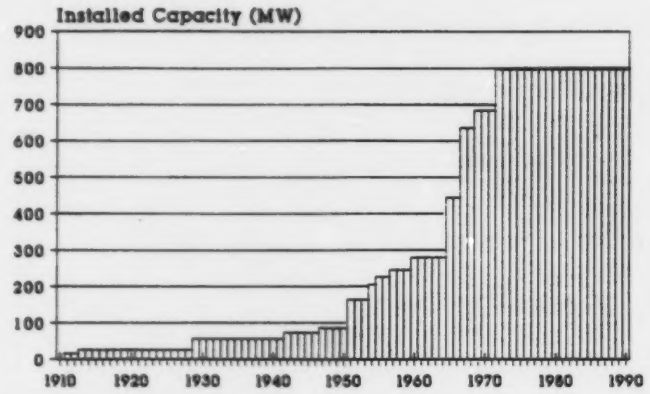
An acre.foot of water is the amount of water required to cover an acrea of one acre to a dept of one foot.

HYDROELECTRIC DEVELOPMENT

INTRODUCTION

The first hydroelectric energy in Alberta was produced on the Bow River in Calgary. The Horseshoe Plant, constructed on the Bow River in 1911, is the oldest of the existing hydro plants in Alberta. Presently there are 14 hydroelectric plants in operation with an installed capacity of about 800 megawatts (MW). Figure 1 shows the growth of installed hydroelectric capacity, starting with the Horseshoe plant in 1911 through the 1960s and 1970s, when over half of the existing installed capacity was commissioned. There has been no hydroelectric capacity installed in Alberta since the early 1970s.

Fig. 1 HYDROELECTRIC CAPACITY GROWTH in ALBERTA



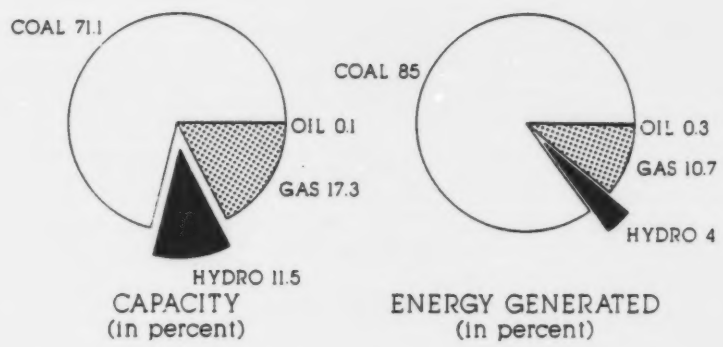
From ERCB Report ERCB ST 90-28

As of December 31, 1989, the combined capacity of existing hydroelectric plants represents about 11.5 percent of the provincial installed electric power generating capacity. Figure 2 illustrates the relative contribution by hydro for both installed capacity and energy generated as of December 31, 1989. While hydro has 11.5 percent of the installed capacity, it produces only about 4 percent of the electric energy produced in the province. Coal-fired generation plants with 71.1 percent of installed capacity produce about 85 percent of the provincial energy requirements.

Figure 2 also shows the role hydro plants perform in meeting the peak power demands that occur during the day and week. Compared to that of coal-fired plants, hydro sources of electricity have a relatively quick response time to changes in power demand. Coal plants are most efficient at producing power at a constant rate while the efficiency of hydro plants is not significantly affected by varying power output. Hydro is therefore favoured to

meet peak needs in power demand. This use explains why the ratio between installed capacity and energy produced is so large for hydro plants found in Alberta.

Fig. 2 RELATIVE CAPACITY and GENERATION by TYPE of ENERGY SOURCE



From ERCB Report ERCB ST 90-28

The relative role of hydro as an energy source in Alberta has been diminishing, but with the growing concerns about the contribution of CO_2 emissions from thermal plants to global warming, as well as depletion of non-renewable resources, hydro developments may find increasing importance in meeting future provincial energy needs.

HYDROELECTRIC DEVELOPMENT IN ALBERTA

Existing Development

The largest concentration of hydroelectric projects in Alberta is situated on the Bow River system upstream of Calgary, where 11 power plants generate about 900 gigawatt hours (GWH) of energy, on average, per year (1 gigawatt = 10^9 watts). These plants are used primarily for producing peaking power. On the North Saskatchewan River system, the Brazeau project, in addition to power production, provides downstream flood control, and by releasing higher water flows to the river during low-flow periods, provides improved river water quality downstream of Edmonton.

Table 1 summarizes the developed and undeveloped hydroelectric potential in Alberta. The developed projects annually produce, on average, 1680 gigawatt hours (GWH) of energy. This figure represents about three percent of the hydroelectric energy potential that is believed suitable for development in the province.

Hydroelectric Potential

As Table 1 indicates, the majority of the undeveloped hydroelectric potential is located in three northern river basins: the Peace, the Athabasca, and the Slave. In 1977, a feasibility study of the Dunvegan site on the Peace River was completed and found that project to be an economically competitive source of electrical energy. The recommendation was also made to assess other hydro sites, specifically the Mountain Rapids site on the Slave River at the Alberta-Northwest Territories border. The Slave River Hydro Feasibility Study was completed in June, 1982. The study confirmed that a hydroelectric project there would be technically feasible and could provide an economically attractive source of electric energy for Alberta.

TABLE 1: HYDROELECTRIC POTENTIAL IN ALBERTA

Drainage Basin	TMHE GWH/Year	DHE GWH/Year	Installed Capacity MW	RDHE[1] GWH/Year
Slave	8570	-		8570
Hay	250	-		-
Peace	38400	-		21540
Athabasca	25700	7.1	1.4	13830
Beaver	70	-		-
North Saskatchewan	15200	770	475	7540
South Saskatchewan	9470	900	326	1840
Red Deer	2710	-		-
Milk	250	-		-
	100620	1680	802	53320

MW - megawatts (10^6 watts)
TMHE - Theoretical Maximum Hydroelectric Energy Potential
DHE - Developed Hydroelectric Energy
RDHE - Remaining Hydroelectric Energy Potential at Identified Sites
GWH/Year - gigawatt hours per year

1 The difference between the theoretical maximum hydroelectric energy potential (TMHE) and the remaining hydroelectric energy potential (RDHE) is related to factors such as suitable damsites and limitations to dam height as it relates to possible flooding of towns and other infrastructures. The RDHE is a scoping estimate based on limited field investigations subject to refinements resulting from any project-related studies. (Source: ERCB Report 81-E)

Development of the hydroelectric energy potential in the northern river basins is governed chiefly by environmental and economic considerations. It is not likely that the hydroelectric potential of these basins will be developed until these considerations compare favourably with alternative sources of electric energy.

Hydro Potential At Water Management Projects

In the South Saskatchewan River basin, water withdrawals from rivers for irrigation purposes have resulted in reduced river flows and have created severe limitations for new hydroelectric projects. However, the dams, chutes, and storage reservoirs developed for irrigation purposes have created limited hydroelectric potential that is presently being developed under the Small Power Research and Development Program and the South West Renewable Energy Initiative. Construction is nearing completion at the Belly River Inlet Chute Power Plant (2.5 MW). Applications have been made to construct hydro electric plants at the Waterton Dam (2.4 MW), the St. Mary Dam (2.0 MW), the Raymond Chute (18.0 MW), and the Chin Chute (11.7 MW). Interest has been expressed at other locations as well.

Developing hydro potential at existing irrigation or storage facilities presents problems such as these:

- Availability of water to generate power is dependent on meeting irrigation needs first.
- Water flows, particularly in irrigation works, are usually seasonal; therefore, hydro facilities are shut down when water is unavailable (winter - November to April inclusive).
- Because of downstream instream flow considerations, peaking power production may be constrained and flow regulation similarly affected.

The advantages of developing hydro-electric plants at existing locations include the following:

- Environmentally safe renewable energy can be produced from an available source not presently being utilized.
- Downstream water quality is not changed with the addition of power-producing facilities.
- Chances of economic viability are increased because the dam has already been paid for.

Recent changes in regulations governing the generation and sale of electricity have made small-scale generation at existing projects viable. On the Red Deer River, installation of 14.9 MW of hydroelectric capacity has been approved for the Dickson Dam. The main purpose of the Dickson Dam was to improve low-flow river water quality and provide flow regulation. The addition of hydroelectric power production will increase the benefits provided by the dam and will also reduce the need for additional non-renewable sources of energy production.

Hydro projects under construction, approved, and under application at existing water management projects total about 52 MW of capacity.

ENVIRONMENTAL CONSIDERATIONS ASSOCIATED WITH HYDROELECTRIC DEVELOPMENT

Hydro projects can have significant impacts on altering the natural cycle of river flows. Rivers in Alberta are characterized by a relatively short high-flow condition as a result of spring snowmelt, and for the rest of the

year, the flow tends to recede toward its lowest levels just before spring runoff. In order to capture the large spring-runoff volume, dams are used to create a reservoir to store the water for controlled release during the remainder of the year. The result is a major change in flow distribution over the year, generally characterized by much lower spring flows and higher flows for the remainder of the year. Added to this general flow redistribution are the water releases from the dam to meet energy requirements during peak power usage either on a daily, weekly, or monthly basis. Flow regulation and short-term fluctuations can lead to negative environmental impacts downstream of dams. For example, lower flows may prevent access by fish to important habitat areas of a river, while rapid fluctuations in flow could detract from recreational use of a river. There are also potential positive benefits associated with power dams that may be beneficial to fisheries and water quality, particularly in flood control areas and areas with abnormally high average low flows.

The creation of reservoirs for hydro projects can result in a variety of impacts. A reservoir is often viewed negatively because of the drastic land-use change (flooding) involved by creating the reservoir. Fluctuating water levels within the reservoir tend to detract from other possible uses of the reservoir, especially the maintenance of a self-sustaining fish population. Shoreline stability, access to the water, and water quality changes may be other areas of concern. On the other hand, reservoirs can provide new opportunities for recreation and fisheries, provide secure water supplies, and can be used to enhance downstream water quality by providing higher discharges during otherwise low-flow conditions.

Many of the impacts associated with hydroelectric developments can be mitigated, to varying degrees, at the project-planning and design stage, and later by the operation of the project. The extent to which the mitigation measures increase the unit cost of the power produced has a significant bearing on whether the project remains competitive with other sources of electrical energy.

EXISTING REGULATORY PROCESSES GOVERNING HYDRO DEVELOPMENT

Overview Of The Licensing Process

The diversion and use of water in Alberta for hydroelectric development is governed by the ***Water Resources Act*** and the Provincial Water Power Regulations.

The ***Water Resources Act*** states that the ownership of all water within the province is vested with the Crown and that its diversion and use must be authorized under the Act. Currently this legislation is administered by Alberta Environment.

The Provincial Water Power Regulations, also administered by Alberta Environment, deal with the specifics of the licensing and operation of water power developments, such as the requirements of an application submission, the process of issuing an interim or final license, the Guarantee Deposit associated with the construction of a proposal, and the applicable annual land and water rentals.

The annual rental for the use of water is the greater of the two amounts determined as follows:

- an amount based upon the horsepower capacity of the development computed at a rate fixed in the interim license, or
- an amount based upon the horsepower-year of electric output and the annual load factor of the power plant.

The owner of a hydroelectric development must submit a report to the Controller of Water Resources detailing use during the previous calendar year. The Controller's office determines the rental payable.

Licensing Procedures

The procedure followed in acquiring a license can be summarized into five steps:

Investigation

The proponent identifies project need and carries out environmental, economic and engineering studies in sufficient detail to submit an application.

Application and Review

The proponent formally applies to the Controller of Water Resources, Alberta Environment, for the right to divert and use water, and submits the required engineering reports and plans to support the application.

Interim Licence

If the proposal is found acceptable after addressing all the concerns from the reviewing agencies and public are addressed, an interim licence is granted by Alberta Environment.

The interim license allows the proponent to construct and operate the project subject to such terms and conditions as may be attached to it.

Inspection and Licence

After the project has been inspected by Alberta Environment and found to be constructed according to plan, and after showing proof that all necessary rights-of-way have been acquired, a licence is issued.

Review of Water Use

During the subsequent operation, the project is periodically reviewed to ensure operation is in accord with the terms and conditions of the approval, and that the water is being used in a beneficial and efficient manner.

Role of the EUPC

In most Canadian provinces, the production of electricity is dominated by a single electric utility. In Alberta, there are different types of electric utilities including two investor-owned utilities (TransAlta Utilities Corporation and Alberta Power Ltd.) that both generate and distribute electricity; two municipally-owned utilities (Edmonton Power and the City of Medicine Hat) that both generate and distribute electricity; and three municipally-owned utilities (the City of Calgary Electric System, the City of Lethbridge and the City of Red Deer) that operate only as distribution utilities. Despite the utilities' organizational diversity, the electric distribution system operates on an integrated basis across the province. This integrated system is referred to as the "Alberta Interconnected System".

In 1969, the three major generating utilities (TransAlta, Alberta Power and Edmonton Power) formed a joint working group to co-ordinate long-term planning so that electricity consumers in Alberta could depend on a reliable and economic supply of electricity in the future. Over a period of years, this working group evolved and expanded into the Electric Utility Planning Council (EUPC). The EUPC also functions as a common voice for the

utilities in dealing with regulatory agencies and with representatives of non-governmental organizations concerned about electric utility issues.

Role of the ERCB

In 1938, the Petroleum and Natural Gas Conservation Board was established. In 1957, it was renamed the Oil and Gas Conservation Board. The purpose of the Board was to ensure that the oil and gas resources of Alberta were developed under regulation designed to promote resource conservation, equity, efficiency and safety. In 1971, this type of regulation was extended to coal and electric energy resources. In that year, two acts were passed continuing and expanding the involvement of the Board in energy resource environmental matters:

- The ***Energy Resources Conservation Act*** continued the Oil and Gas Conservation Board as the Energy Resources Conservation Board (ERCB) and defined its broad responsibilities over all energy resources.

- The ***Hydro and Electric Act*** assigned to the ERCB specific responsibilities relating to the resource management and environmental matters with respect to hydro and electric power.

Basic environmental requirements and standards, however, are defined by the Department of Environment. The ERCB is the regulatory body for approval of hydroelectric development. The approval process considers resource conservation, environmental, and economic considerations associated with a development. The Board also monitors the Alberta electric industry on a continual basis to facilitate long range planning and development of new electric generating plants.

The Role of the Department of Energy

The Alberta Government indicated its support for small power generation from renewable sources by establishing the ***Small Power Research and Development Act*** and Program administered by Alberta Energy. Under the Small Power Research and Development Program, project capacity is not to exceed 125 MW and eligible power production facilities must produce electricity from hydro, wind, or biomass energy sources. Under the Act, the public utility shall pay to the small power producer a minimum rate for the term of the contract.

THE FUTURE OF HYDROELECTRIC DEVELOPMENT

Hydro power has a connotation of "clean power" compared to other energy sources, with the exception perhaps of solar, wind and, to some extent, geothermal sources. With increasing public awareness of environmental concerns and the depletion of non-renewable resources, hydroelectric energy may be viewed a more "friendly" energy source in the future. As indicated in Figure 1, there has not been any significant hydro capacity installed in Alberta since the early 1970s, a period also characterized by relatively high interest rates after accounting for inflation. Since hydro projects are very capital intensive, economic conditions favoured thermal projects that have lower capital costs but much higher operating costs. Today's lower interest rates will tend to increase the economic viability of hydro projects. This, combined with increasing concern about "greenhouse gases" emitted from thermal plants, may result in new appraisals of the hydroelectric potential in the province. Future decisions on development of electric power will have to reflect the comparative advantages of hydro over coal and other fossil fuels on the basis of environmental impacts as well as economics.

Another factor that may stimulate hydro development opportunities is the trend to closer integration of the electric utilities across the nation and continent. Economic benefits are attainable for individual utilities by

interconnections between the utilities' distribution systems. The benefits arise from the synergy provided by fitting together the differences in types of generating capacity (i.e., thermal and hydro) and the variations in power demands that exist among utilities.